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SPACE STATION FREEDOM PRIMARY POWER WIRING REQUIREMENTS

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SPACE STATION FREEDOM PROGRAM REQUIREMENTS

- 30 YEAR RELIABLE SERVICE LIFE IN LOW EARTH ORBIT
IN HARD VACUUM OR PRESSURIZED MODULE SERVICE
WITHOUT DETRIMENTAL DEGRADATION.
- IN ENGINEERING TERMS, THIS IS:
 - 263,000 HOURS SERVICE OVER 175,000 ORBITS.
 - PREDICTED THERMAL CYCLES OF 0 TO 100 DEG. C
EXPOSED, OR UP TO 30 % OXYGEN INTERNAL.
 - TOTAL MASS LOSS MUST BE < 1%
 - VOLATILE CONDENSIBLE MATERIAL < 0.1% OR LESS
 - MUST SURVIVE PREDICTED HOSTILE ENVIRONMENTS:
ATOMIC OXYGEN, VACUUM ULTRA-VIOLET, PLASMA,
RADIATION, AND MICROMETORIODS.
 - MUST RETAIN GOOD MECHANICAL AND ELECTRICAL
PROPERTIES AT END-OF-LIFE.

SSF PRIMARY POWER SPECIFIC REQUIREMENTS

- WORK PACKAGE 4 /ROCKETDYNE DESIGN FOR POWER DISTRIBUTION IS BASED ON POWER QUALITY, VOLTAGE DROP CONSIDERATIONS. WIRE GAGES #4 AND #1/0 WERE SELECTED.
- INSULATION TRADE STUDIES WERE RUN TO SELECT THE BEST CANDIDATES FOR PRIMARY POWER WIRES.
 - POLYIMIDE WAS EXCLUDED EARLY BECAUSE OF MECHANICAL STIFFNESS IN #4 AND #1/0 GAGES.
 - FLUOROPOLYMER (MIL-STD-22759-41) AND SILICONE OFFER BEST PROPERTIES SO FAR. AGEING TESTS ARE BEING RUN ON ALL CANDIDATES.
 - ALL INSULATIONS DEGRADE UNDER AO, VUV, MM, ETC. WP-4 WILL ENCLOSE ALL PRIMARY WIRING IN CONDUIT.

SSF CABLE INSULATION SPECIFIC REQUIREMENTS

- ELECTRICAL PROPERTIES- TO END OF LIFE
 - GOOD DIELECTRIC STRENGTH (180 VDC MAX)
 - HIGH INSULATION RESISTANCE
 - HIGH DRY ARC TRACKING RESISTANCE
- MECHANICAL PROPERTIES- TO END OF LIFE
 - LIGHT WEIGHT FOR REQUIRED WALL THICKNESS
 - HIGH ABRASION RESISTANCE
 - FLEXIBILITY, FLEX LIFE, COLD BEND TO -100 DEG. C
 - 200 DEG. C OPERATING TEMPERATURE RATING
 - LONG LIFE AT 100 DEG. C PREDICTED TEMPERATURE
 - OFFGASSING, TOXICITY, FLAMMABILITY TESTS
 - ATOMIC OXYGEN + VACUUM-ULTRA VIOLET, PLASMA, RADIATION RESISTANT
 - FOR MODULES, 30 % OXYGEN @ 10 PSI FLAME TEST

SSF PRIMARY POWER CABLE STATUS

- BY FAR, THE MOST SIGNIFICANT DESIGN REQUIREMENT IMPOSED ON SSF POWER CABLES IS 30 YEAR LIFETIME IN SPACE ENVIRONMENT.
- THE ROCKETDYNE - WP-4 PLAN IS TO DERRIVE LONG TERM THERMAL CYCLING DATA AND A LIFE PREDICTION METHODOLOGY BASED ON TESTING.
- WP-04 - ROCKETDYNE DECISION TO ENCLOSE CABLE IN CONDUIT RELIEVES MANY EROSION/IMPACT ISSUES, BUT SUCH TESTS WILL BE RUN ANYWAY.
- ROCKETDYNE MATERIALS AND PROCESSES EXPERTS ARE WORKING WITH THEIR SCIENCE CENTER TO DEVISE THERMAL CYCLE, TENSILE, AND AGEING TESTS TO APPLY TO ALL CANDIDATE INSULATIONS.

WP-4 PLANNED CABLE TEST PROGRAM

- INSULATION TESTS, MULTIPLE SAMPLES, ALL CANDIDATES:
 - LONG TERM MECHANICAL CYCLING OF SAMPLE,
 - LONG TERM THERMAL CYCLING OF SAME SAMPLE,
 - TORSION PENDULUM TEST TO DETECT DEGRADATION.
- CABLE TEST PROGRAM
 - THERMAL MODEL FOR EACH CONFIGURATION.
 - SCALED VACUUM CHAMBER TESTS TO VERIFY MODEL.
 - RADIATED EMISSIONS TESTS OF CABLES AND GROUND.
 - TESTING FOR EVA COMPATIBILITY.
 - PRODUCTION TESTS FOR PRODUCIBILITY/HANDLING.
 - FLIGHT CONFIG. CABLES USED FOR GROUND TESTS.
- A SPECIAL TEST IS PROPOSED FOR LONG CABLE RUNS TO MEASURE EXPANSION AND CONTRACTION EFFECTS.

ROCKETDYNE-WP04 PRIME INSULATION CANDIDATES

- THE SSQ SPECIFICATION FOR POWER WIRE AND CABLE IS SSQ 21656
- ETFE (ETHYLENE-TETRAFLUOROETHYLENE COPOLYMER) IS DUPONT (R) TEFZEL.
- XL-ETFE IS A CROSSLINKED VERSION OF TEFZEL PER ROCKETDYNE SPECIFICATION RE2432. THIS IS SIMILIAR TO MIL-W-22759-41, BUT MODIFIED TO USE FINER STRANDS, MORE FLEXIBLE TEFZEL, AND NO OUTER BRAIDED JACKET.
- THE SILICONE INSULATION CANDIDATES INCLUDE MDAC PROVIDED GENERAL ELECTRIC SE6660, PHENYL-DIMETHYL (PVMQ).

OTHER DATA, LIMITS, AND TEST-TO PARAMETERS AT THIS TIME, SUBJECT TO CHANGE

- ATOMIC OXYGEN REFERENCE FLUX: $4.1E+14$ AO/CM SQ-SEC
- ARC TRACKING: TEST PER NASA NHB 8060.1C TEST 18
- RADIATION: 30 YEAR EXPOSURE $3.6E+4$ RADS
- PLASMA: DESIGN REFERENCE PLASMA $4.5E+6$ IONS/CM³
- FLAMMABILITY: NO FLAME SUPPORT, NASA NHB 8060.1C 401 #1 AT 10 PSIA 30% OXYGEN.
- OUTGASSING: UNLESS ALREADY TESTED AND DATA SUBMITTED FOR INCLUSION INTO MSFC-HDBK-527/JSC 09604, SAMPLES SHALL BE TESTED TO NASA JSC SP-R-0022, AND DATA SUBMITTED TO NASA FOR EVALUATION.
- OFFGASSING: MATERIAL SAMPLES SHALL BE TESTED PER NASA NHB 8060.1C, 407 TEST 7. MAXIMUM ALLOWABLE CONCENTRATION (MAC) VALUES IN APPENDIX D ARE NOT TO BE USED AS PASS/FAIL CRITERIA, BUT DATA SUBMITTED TO NASA FOR EVALUATION.